# United States Patent [19]

**Borg**

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[45] **Date of Patent: Mar. 18, 1986**


[54] **REVERSIBLE MAGNUS PROPELLER**


[76] Inventor: **John L. Borg,** 8200 Toro Creek Rd., Atascadero, Calif. 93422



[21] Appl. No.: **595,306**

[22] Filed: **Mar. 30, 1984**

**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 325,741, Nov. 30, 1981, abandoned.

[51] **Int. Cl.**[4] ........ **B63H 23/16**

[52] **U.S. Cl.** ........ **440/86;** 244/206; 416/4

[58] **Field of Search** ........ 244/206, 10, 21, 51; 416/146 R, 146 B, 4; 440/86, 51, 91–93; 415/90; 74/665 F, 665 H, 665 P, 378, 379, 321, 385, 347, 353, 355; 114/144 R, 144 RE


[56] **References Cited**

U.S. PATENT DOCUMENTS


| | | | |
|---|---|---|---|
| 439,036 | 10/1890 | Omstead | 74/321 |
| 1,041,825 | 10/1912 | Low | 416/4 |
| 1,834,558 | 12/1931 | Wander | 416/4 |
| 2,307,418 | 1/1943 | McDonald | 416/4 |
| 2,916,095 | 12/1959 | Mades | 416/146 B |
| 4,225,286 | 9/1980 | Fork | 416/4 |

FOREIGN PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| 659443 | 6/1929 | Fed. Rep. of Germany | 416/4 |
| 2006885 | 5/1929 | United Kingdom | 416/4 |



*Primary Examiner*—Trygve M. Blix
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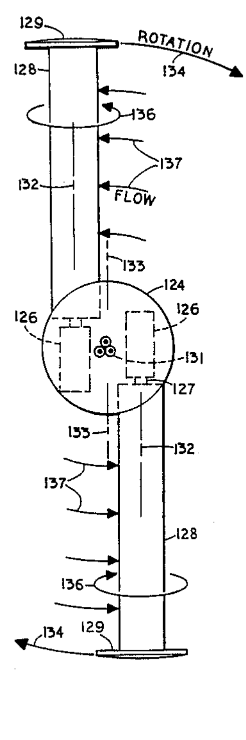
*Attorney, Agent, or Firm*—Harry W. Brelsford


[57] **ABSTRACT**


The thrust of a Magnus propeller is made reversible by reversing the rotation of the Magnus cylinders independently of the direction of rotation of the propeller shaft. Reversible drives for the cylinders are provided that are mechanical, fluid or electric. Reversible motors for the propeller shaft are provided as an alternative reversing mechanism while the cylinders continue to rotate in the same direction. Separate motor drives are provided for the Magnus cylinders and the propeller shaft.


**11 Claims, 17 Drawing Figures**



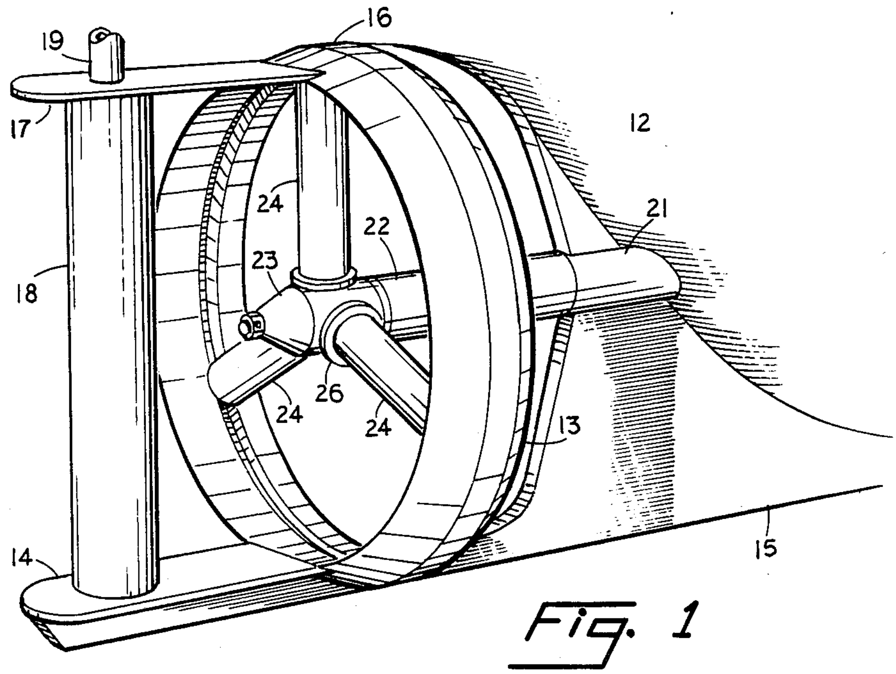

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Fig. 1

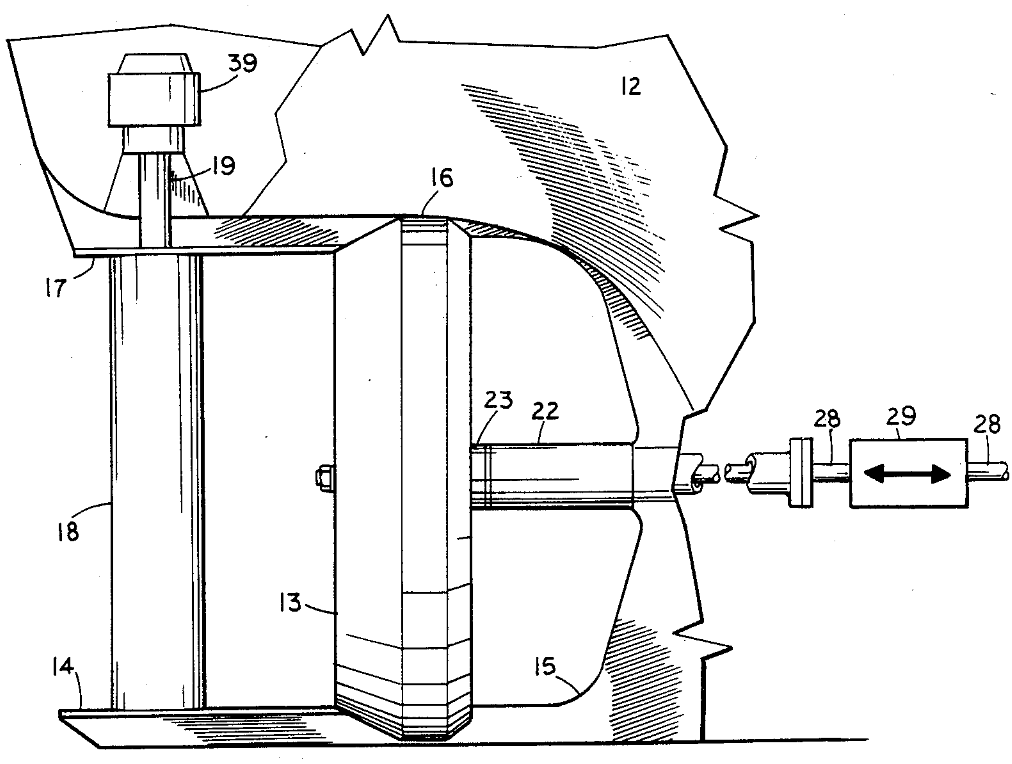
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Fig. 2

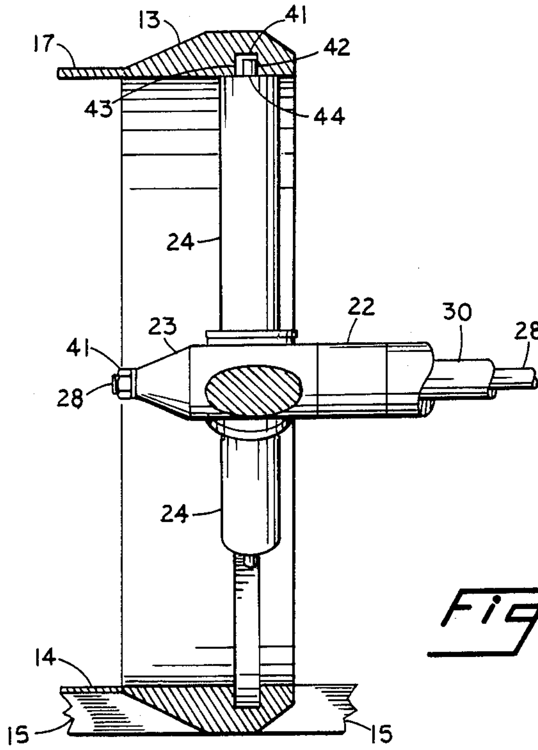
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Fig. 3

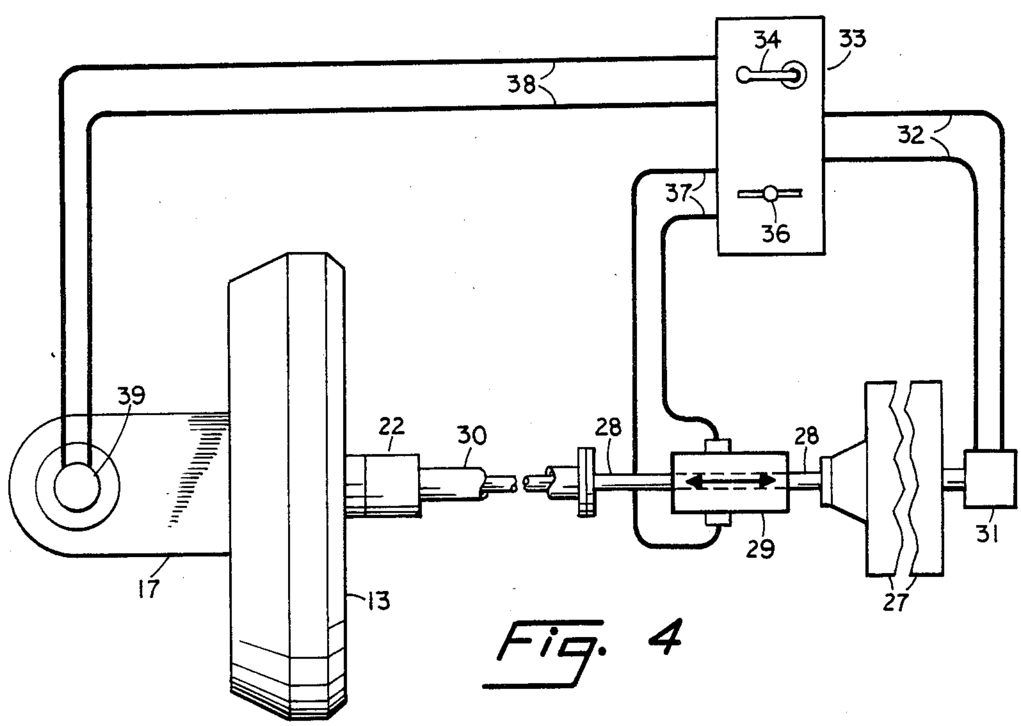
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Fig. 4

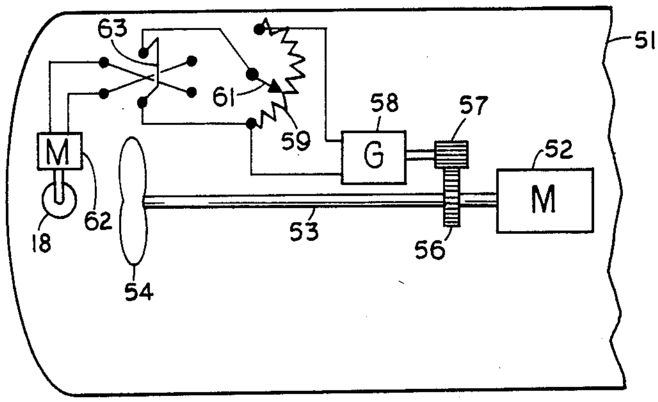


Fig. 5

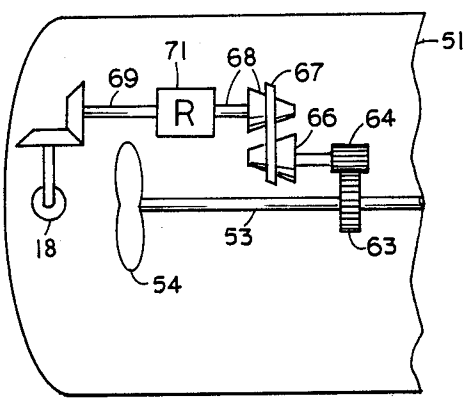


Fig. 6

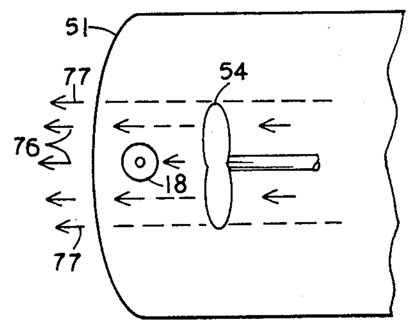


Fig. 8

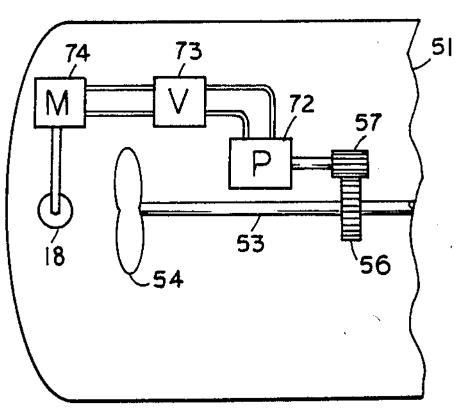


Fig. 7

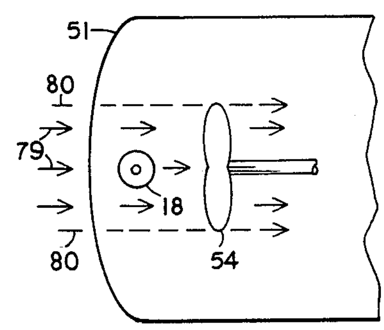


Fig. 9

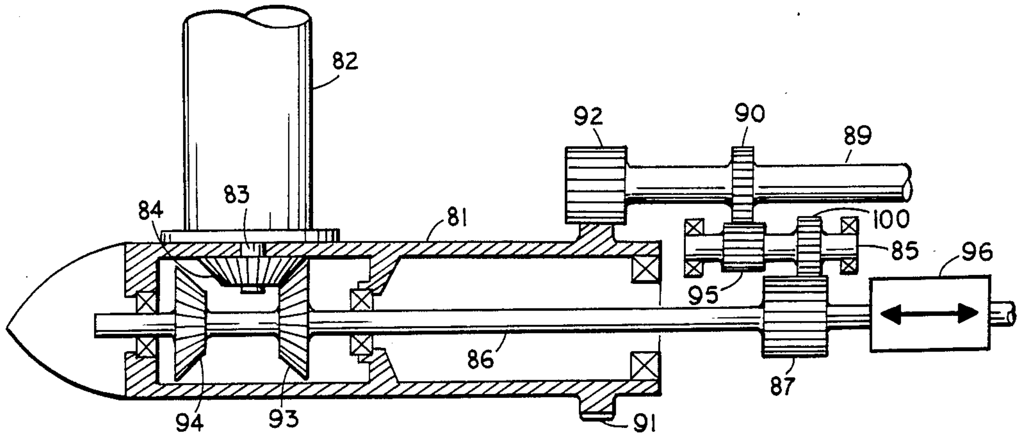


Fig. 10

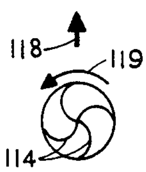


Fig. 11B

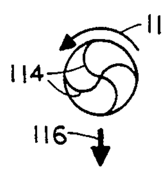


Fig. 11A

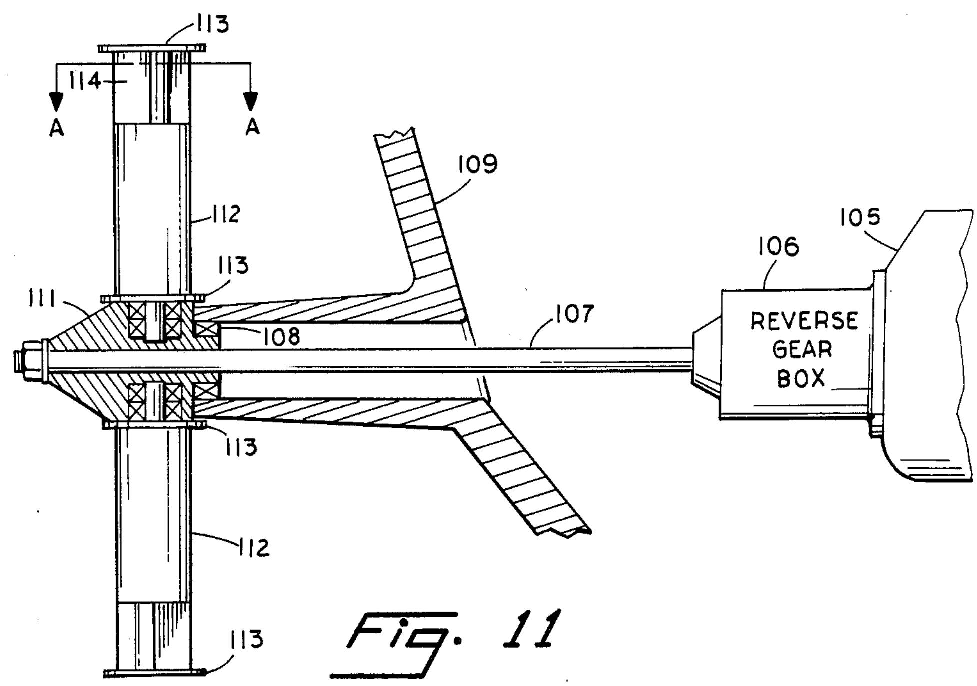


Fig. 11

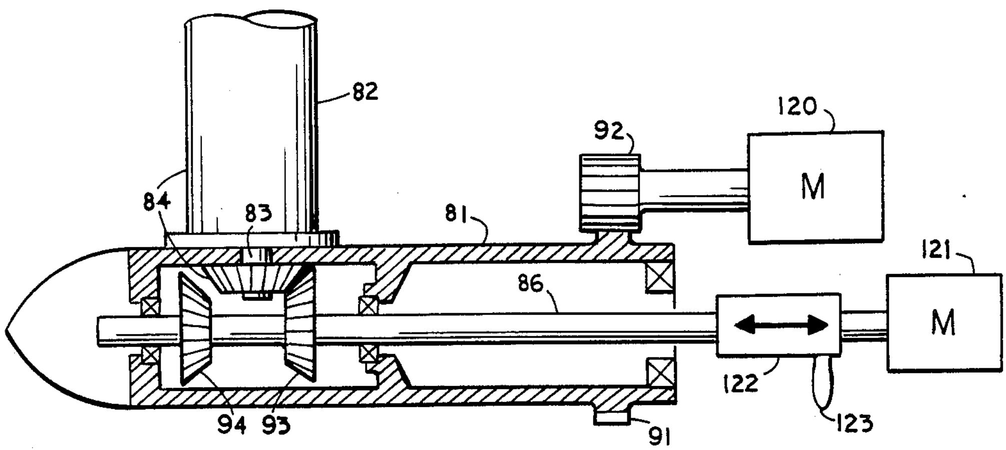


Fig. 12

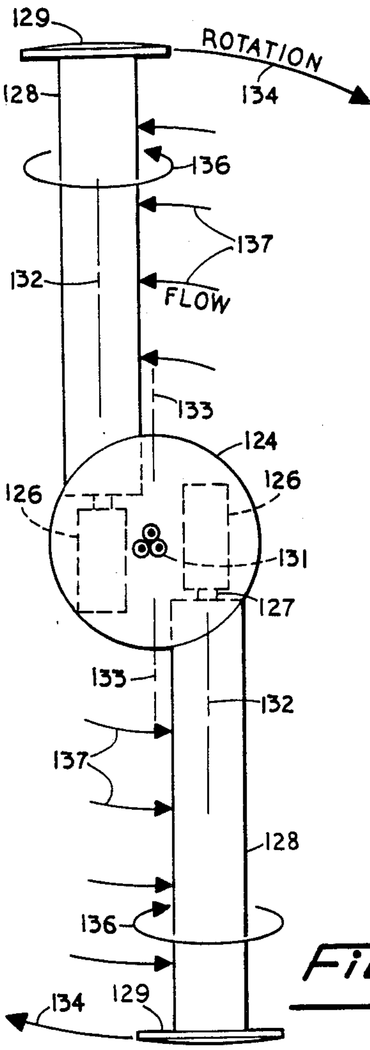


Fig. 13

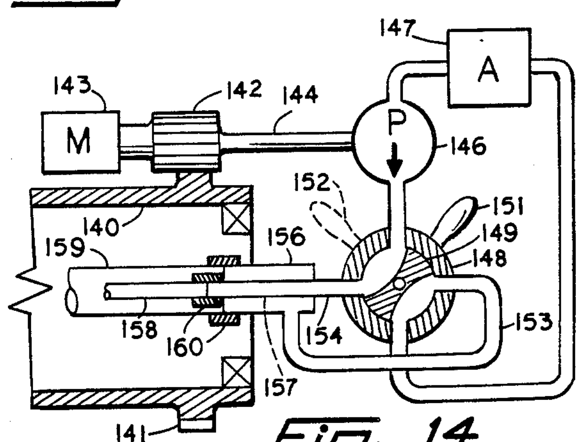


Fig. 14

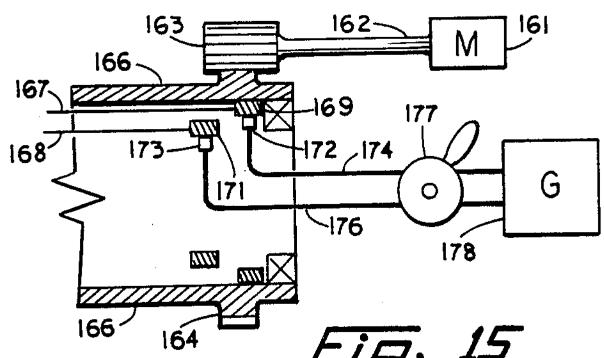


Fig. 15

## REVERSIBLE MAGNUS PROPELLER

This is a continuation-in-part of my copending application Ser. No. 325,741 filed Nov. 30, 1981, now abandoned.

### TECHNICAL FIELD

This invention relates to propellers for boats and ships and has particular reference to reversible Magnus effect propellers.

### BACKGROUND OF THE PRIOR ART

The Magnus effect was first publicized by Professor G. Magnus in 1853. The phenomenon is well-known in various arts including the curved pitches of baseball and the shooting of airplane guns transversely to the airplane's path of travel. The use of the Magnus effect as a rudder for a boat was disclosed in 1929 in U.S. Pat. No. 1,697,779. Other patents disclose the use of the Magnus effect for airplane lift and other use for assisting in submarine steering. Briefly stated, when a rotating cylinder encounters a fluid flow at an angle to its rotational axis, a lifting force is created perpendicularly to the flow direction. If a rotating cylinder is mounted on a vertical axis, a force is developed at right angles to the direction of water flowing past the cylinder, left or right depending upon the direction of rotation. The Magnus effect is therefore ideal for rudders for boats.

The control of Magnus effect rudders for boats and other watercraft has not heretofore been developed on an efficient basis, that is, obtaining the maximum amount of steering for a given expenditure of energy to rotate the Magnus cylinder.

### BRIEF SUMMARY OF THE INVENTION

I have discovered that the peripheral speed of a Magnus rudder should be closely regulated to the velocity of the water passing the Magnus cylinder. If the Magnus rudder depends upon the forward or backward motion of the boat or ship for flow past the Magnus rudder, there will be no steering when the boat has no motion with respect to the water. I avoid this no performance condition by placing the Magnus rudder in the slip stream, forward or reverse, of the propeller of the boat or ship. In this fashion, steering is obtained even when the boat is stationary with respect to the water. I have determined that the maximum steering takes place when the peripheral speed of the Magnus drum is four times the velocity of water flow past the Magnus rudder. Any added peripheral speed is generally wasted as large increases in peripheral speed give only small increases in steering effort. The increase in peripheral speed over the optimum ratio requires large expenditures of power and this power is generally wasted.

I have further found that within reasonable limits the speed of water flowing around a Magnus effect rudder placed in the propeller slip stream is closely related to the r.p.m. of the propeller and this in turn is directly related to r.p.m. of the motor driving the propeller.

I therefore regulate the maximum peripheral speed of my Magnus rudder by relating it to the r.p.m. of the motor or engine driving the propeller. This can be done by a generator-motor relationship, mechanical drive including a variable transmission, or hydraulically by hydraulic pump driving a hydraulic motor. In each case, however, means must be provided to give a range of Magnus rotation from zero to maximum so that the



boat operator can select any desired amount of steering at any time.

### BRIEF DESCRIPTION OF THE DRAWINGS

Various objects, advantages and features of the invention will be apparent in the following description and claims, considered together with the drawings forming an integral part of this specification and in which

FIG. **1** is a three dimensional view of a Magnus propeller associated with a Magnus rudder at the stern of a vessel.

FIG. **2** is an elevation view of the Magnus rudder and the Magnus propeller of FIG. **1**.

FIG. **3** is an elevation of view with part of the nozzle broken away to show the detailed construction of the Magnus propeller of FIG. **1**.

FIG. **4** is a plan view of the drive system for the Magnus propeller and the Magnus rudder employing hydraulic power.

FIG. **5** is a schematic plan diagram of the control of the maximum Magnus rudder peripheral speed by means of a generator-motor circuit.

FIG. **6** is a plan view of a schematic control for the maximum peripheral speed of the Magnus rudder employing a mechanical drive between the propeller shaft and the Magnus rudder.

FIG. **7** is a plan view of a schematic circuit for controlling the maximum peripheral speed of a Magnus rudder by use of a hydraulic circuit driven by the propeller shaft.

FIG. **8** is a diagram of a boat showing the flow of water past the Magnus rudder when the propeller is rotated in the direction to drive the vessel forward.

FIG. **9** is a diagram of a boat wherein the propeller is rotated in a direction to cause the boat to move backward and also creating a flow past the Magnus rudder.

FIG. **10** is a fragmentary sectional view of a modified form of a Magnus propeller wherein the rotation occurs by means of bevel members within the hub of the Magnus propeller.

FIG. **11** is an elevation view partly in section of a Magnus propeller that has auto rotating cylinders. FIGS. **11** A and **11** B are schematic sectional views along the line A—A of FIG. **11**.

FIG. **12** is an elevation view, partly in section, of a modified form of Magnus propeller wherein the cylinders and propeller shaft have independent mechanical motor drives.

FIG. **13** is a diagram of a modified form of Magnus propeller as viewed from the rear of a vessel as the vessel is moving forward away from the viewer, and in which the cylinders have (fluid or electric) motors located inside the propeller hub, and which are independent of the propeller shaft motor.

FIG. **14** is a schematic diagram of an electrical drive for the cylinder motors of FIG. **13**.

FIG. **15** is a schematic diagram of a fluid drive system for the cylinder motors of FIG. **13**.

### DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. **1** there is illustrated the hull **12** of a boat having a skeg **15** projecting therefrom which supports the bottom edge of an annular nozzle **13** as well as a rotor flange **14**. The upper part of the nozzle **13** is secured to the boat hull **12** at **16** and projecting from this nozzle is an upper flange plate **17**. Mounted for rotation in the flange plates **14** and **17** is a Magnus rudder rotor **18** driven by a shaft **19** projecting through the upper flange plate **17**. Also supported by the skeg **15** is a propeller shaft housing **21** terminating in a propeller shaft bearing **22**. Rotatable within the bearing **22** is a propeller shaft not shown in FIG. **1** which rotates a propeller hub **23** from which project three radial cylinders **24** which are rotatable on the hub **23** about radial axes. Each cylinder **24** has adjacent to the hub **23** an annular flange **26** which is necessary in order to obtain maximum Magnus effect as the radial cylinders **24** rotate on their radial axes. The nozzle **13** acts as an outer flange for these rotatable Magnus propeller blades **24**.

Referring now to FIGS. 2 through **4**, there is illustrated the mechanism for driving the Magnus propeller as well as the mechanism for controlling the rotary speed of the Magnus rudder **18**. Referring especially to FIG. **4** there is illustrated a motor **27** driving a propeller shaft **28** through a coupling actuator **29**. The propeller shaft **28** rotates within a stationary tube **30** connected to the propeller shaft bearing **22**. The motor or engine **27** also has connected to it a hydraulic pump **31** having conduits **32** leading to a valve housing **33** which has a speed regulator manual control **34** and a reversing manual control **36**. The reversing control **36** controls a flow of liquid through a pair of hydraulic lines **37** leading to the reversing coupling **29**. The reversing coupling **29** shifts the propeller shaft **28** along its axis of rotation to effect reversal of the propeller as will be described hereinafter. The unit **29** merely shifts portions of the shaft **28** that are joined together by means of splines or other mechanical connection that allows one part of the shaft **28** to slide with respect to the other. Referring now to the manual control **34** this controls the amount of hydraulic liquid passing through a pair of conduits **38** to a hydraulic motor **39** which is connected to the rudder shaft **19** shown in FIG. **1**. Also illustrated in FIG. **4** is the upper flange plate **17** for the upper end of the Magnus rotor **18** described in FIG. **1**.

Referring to FIG. **2** the motor **39** is there illustrated together with the hull **12** of the boat, ship or other vessel on which the mechanism is placed.

Referring now especially to FIG. **3** it will be noted that the propeller shaft **28** is securely fastened to the propeller hub **23** by means of a nut **41**. Therefore when the shaft **28** is reciprocated along its axis of rotation a small amount the entire hub **23** moves with it. It will be noted in FIG. **3** that the nozzle **13** has an internal annular groove **41** having a forward edge **42** and a rearward edge **43**. Projecting from the outer end of each of the propeller cylinders **24** is a solid projection **44** in the form of a pin which may be tapered if desired. This pin **44** of each rotor makes a frictional engagement with either the forward edge **42** or the rearward edge **43** of the groove **41** to thereby rotate the associated cylinder **24**. The propeller cylinders **24** accordingly rotate on their radial axes as they revolve about the propeller shaft. The direction of rotation with respect to the direction of revolution decides whether or not a thrust is developed that will propel the ship hull **12** forward or propel the ship hull to the rear. The structure illustrated in FIG. **3** permits the propeller shaft to rotate continuously in the same direction regardless of whether a thrust is created that will propel the ship forward or which will propel the ship to the rear. The only change therefore is in the direction of rotation of each of the propeller cylinders **24**. The actuation of the shifting coupler **29** accordingly controls whether the boat moves in a forward direction or in a rearward direction.

## OPERATION OF FIGS. 1–4

The Magnus propeller consisting of the hub **23**, the propeller cylinders **24** and the nozzle **13** is actuated by rotation of the hub **23** this is done by means of the engine **27** driving a propeller shaft **28** through the splined coupling **29**. As will be noted in FIG. **3** the rotation of the propeller cylinders **24** about the propeller shaft **28** causes them also to rotate on their radial axes because of the engagement of the pin **44** with either the forward edge **42** or the rearward edge **43** of the groove **41**. Accordingly when the coupler **29** is shifted to the right this causes the engagement of the pin **44** shown in FIG. **3**. When the coupler **29** is actuated to move the entire hub **23** to the rear then the pin **44** of each cylinder **24** will engage the rear wall **43** causing rotation of each propeller cylinder **24** in the opposite direction to create a force 180° from that previously obtained. This shifting of the coupler **29** is performed by operation of the manual valve lever **36**. The amount of rotation of the Magnus rudder cylinder **18** is controlled by the manual valve lever **34**. If only a slight amount of turning action is desired the pilot or other operator of the valve lever **34** moves it only a slight amount to let in a slight amount of liquid to the hydraulic motor **39** which rotates the Magnus rudder cylinder **18**. If, however, maximum turning effort is required then in accordance with the invention the entire output of the hydraulic pump **31** is directed to the hydraulic motor **39** and the parameters of pump, motor and diameter of the Magnus cylinder **18** are so selected that the peripheral speed of the Magnus rudder cylinder **18** is not in excess of **4** times the speed of the wash or propeller stream past the Magnus rudder cylinder **18**. In this fashion I conserve the energy that might otherwise be wasted with excessive rotational speed of the Magnus rudder **18**. This, as mentioned previously is based on my finding that the speed or velocity of the propeller stream past the Magnus rudder is controlled almost directly by the rotational speed of the propeller shaft **18**. This in turn is controlled by the rotational speed of the motor **27**. Accordingly drive shaft rotational speed is a direct measure of the amount of rotational speed for the Magnus rudder, and this is obtained by means of the direct drive hydraulic pump **31** and the hydraulic motor **39** driven by the output of this pump.

Referring now to FIGS. **5**, **6** and **7**, there is illustrated in FIG. **5** an electrical system for achieving the maximum amount of rudder rotation with respect to the propeller shaft rotational speed. In that FIG. **5** a ship **51** has a motor **52** driving a propeller shaft **53** which may have a conventional propeller **54** secured thereto. Mounted on the propeller shaft **53** is a gear **56** which drives a smaller gear **57** which in turn drives an electrical generator **58** the output of which passes across a variable resistance **59**. A takeoff arm **61** selects the desired amount of current to drive an electric motor **62** which in turn drives a Magnus rudder cylinder **18**. A reversing switch **63** reverses the direction of the rotation of the rudder **18**. The maximum output of the generator is utilized when the takeoff arm **61** is at the top of its sweep and this maximum output of the generator drives the motor **62** at such a speed that the peripheral speed of the rudder cylinder **18** is not in excess of **4** times the flow speed generated by the propeller **54** for any selected motor r.p.m.

Referring now to FIG. **6** a propeller shaft **53** drives a propeller **54** but in this case a gear **63** on the propeller shaft drives a smaller gear **64** which in turn drives a cone **66** forming part of a variable transmission including a belt **67** which drives another cone **68**. This in turn drives a shaft **69** which rotates the Magnus rudder cylinder **18**. A reversing gear shifter **71** allows for reversal of the direction of rotation of the Magnus rudder **18** to give thrust either to the right or to the left as desired. Again, the structure of FIG. **6** is such that the maximum speed of rotation of the Magnus rudder **18** is related to the rotational speed of the propeller shaft **53** and this relationship is **4** times the peripheral speed of the rudder **18** related to the propeller stream velocity from the propeller **54**.

Referring to FIG. **7** there is illustrated a modified form of a hydraulic control system wherein the propeller shaft **53** drives a gear **56** which in turn drives a smaller gear **57** to operate a hydraulic pump **72**. This in turn supplies fluid under pressure to valve **73** which may incorporate a reversing feature as well as a regulating feature. This valve delivers liquid under pressure to a hydraulic motor **74** which in turn drives the Magnus rudder **18**. At maximum rudder action the relationship of the pump and motor and rudder **18** are such that the flow past the rudder will be at **1/4** of the peripheral speed of the rotor **18**. Accordingly, therefore, regardless of the velocity of stream flow caused by the propeller **54**, the relationship will be maintained in this **4** to **1** ratio, thus realizing considerable savings of energy by avoiding excessive rotational speed for the rudder **18** under the varying conditions.

Referring to FIGS. **8** and **9** there is illustrated a diagram of the boat having a propeller and showing the propeller stream flow past a Magnus rudder for both propulsion of the ship in a forward direction and propulsion of the ship in a rearward direction. Referring to FIG. **8** a boat **51** has a propeller **54** which creates a propeller stream flow towards the rear as indicated by the arrows **76** and this stream flow has an outer boundary **77**. The propeller **54** accordingly creates a flow past a Magnus rudder **18** which is in the form of a rotatable cylinder rotating about a vertical axis. The disclosure in FIG. **9** is similar to FIG. **8** except that the propeller now produces a propeller stream that directs water towards the front of the ship **51**. In this case also the stream is indicated by arrows **79** and the outer boundaries of the stream flow are indicated by lines **80**. In this fashion the Magnus rudder **18** will function whether the propeller directs water towards the rear or whether it directs water towards the front of the vessel. It will be appreciated however, that the direction of rotation of the Magnus rudder **18** must be changed if the direction of the propeller stream changes, in order to get steering in a given direction.

Referring to FIG. **10** there is illustrated a modified form of drive for rotating the Magnus cylinders of a Magnus propeller such as the array shown in FIG. **1**. In this case the Magnus cylinders are driven by mechanisms within the hub itself. A hollow propeller shaft **81** has mounted on its left end one or more Magnus cylinders **82** having a bearing on the hollow propeller shaft **81** at **83**. Secured to the bottom end of the bearing shaft **83** is a conical member **84** which for example, may be a bevel gear or a bevel contact surface. Mounted for rotation within the propeller shaft **81** is a cylinder drive shaft **86** which rotates in a direction opposite from the hollow propeller shaft **81**. Both shafts **81** and **86** are driven by drive shaft **89** having a spur gear **92** engaging a spur gear **91** secured to the hollow propeller shaft **81**. The drive shaft **89** also has a spur gear **90** engaging a gear **95** on a counter shaft **85**. The counter shaft **85** also has a gear **100** contacting a spur gear **87** on the cylinder drive shaft **86**. In this fashion the cylinder shaft **86** is driven in the opposite direction from the propeller shaft **81**.

Secured to the left end of the cylinder drive shaft **86** are a pair of spaced bevel members **93** and **94** which may be bevel gears or bevel contact members. On the right end of the shaft **86** is a longitudinal shifter **96** which can shift the shaft **86** right or left while it is rotating. When the shaft **86** is shifted to the left as illustrated in FIG. **10** the bevel member **93** contacts the bevel member **84** to rotate the cylinder **82** in a given direction. When the drive shaft **86** is shifted to the right then the bevel member **94** engages the bevel member **84** to rotate the Magnus cylinder **82** in the opposite direction. In this fashion a Magnus propeller can be changed in its direction of directing the propeller stream by shifting the cylinder drive shaft **86** axially rather than reversing the direction of rotation of the propeller shaft. The use of a cylinder drive shaft rotating in a direction opposite from the propeller shaft, reduces the size of the bevel gears or bevel members in the hub necessary to drive the Magnus cylinders in rotation.

Referring to FIG. **11** there is illustrated a Magnus type of propeller that can be substituted on the shaft of a conventional propeller; in this case the Magnus cylinders of the propeller are provided with vanes that cause the cylinder to rotate as they are revolved around the propeller axis.

Referring to FIG. **11** there is illustrated a conventional engine **105** having a conventional reverse gear box **106** which drives a conventional propeller shaft **107**. This shaft **107** is mounted in a conventional propeller bearing **108** situated conventionally in the hub **109** of a boat or ship. Secured to the left end of the shaft **107** is a propeller hub **111** and mounted within this hull for rotation are a plurality of Magnus cylinders **112** having the usual Magnus flanges **113** at each end. Provided particularly in accordance with the improvement are a series of vanes at the outer end of each Magnus cylinder **112**. These vanes are designated as **114** and are shown in more detail in FIGS. **11**-A and **11**-B. Referring to FIG. **11**-A when the Magnus cylinders are moved through the water in the direction of the arrow **116** the cylinders will rotate in the direction of the arrow **117**. Referring to FIG. **11**-B when the Magnus cylinders move through the water in the direction of the arrow **118** the vanes **114** will cause the cylinder to rotate in the direction of the arrow **119** and it will be noted that the rotation is in the same direction for both FIGS. **11**-A and **11**-B.

The operation of the structure FIG. **11** is as follows. When the propeller shaft **107** rotates the hub **111** in one direction shown by the arrow **116** of FIG. **11**-A then a thrust will be developed at right angles to this direction of motion **116**. If however, the reverse gear box **106** is operated to reverse the direction of rotation of the propeller shaft **107** then the motion of the cylinders **112** is shown by the arrow **118** in FIG. **11**-B and this causes a thrust to be developed 180° from the thrust developed in FIG. **11**-A.

Illustrated in FIG. **12** is the mechanical drive propeller of FIG. **10** wherein the propeller shaft **81** is driven by a motor **120** which is independent of a motor **121** which drives the cylinder drive shaft **86**. Interposed between the motor **121** and the cylinder drive shaft **86** is a shifter **122** which may be operated in any suitable fashion, for example by the manual handle **123**. Because of the independent power drive for the hollow propeller shaft **81** and the cylinder drive shaft **86**, any combination of relative speeds of rotation may be obtained between these two rotatable members. Reversal of thrust from the propeller is obtained as in the FIG. **10** structure by merely shifting the cylinder drive shaft **86** horizontally.

Illustrated in FIG. **13** is a modified form of the invention wherein Magnus cylinders are driven by motors located in the hub portion of a hollow propeller shaft. FIG. **13** is a view from the stern of a vessel showing the dynamics of the propeller as it is propelling a vessel forward away from the viewer. A hollow hub **124** houses a pair of motors **126** which are of the rotatable output type and each motor is connected by a shaft **127** to a Magnus cylinder **128** each terminating in a dished cap **129**. The motors **126** are supplied with a power by means of conduits or conductors **131** disposed within the hollow hub and its associated propeller shaft. Each cylinder **128** rotates on an axis **132** that is parallel to a radius **133** from the hub **124**. The axes **132** could coincide, of course, with a radius by making the hub bigger or the motors **126** smaller to fit that particular type of geometry.

The dynamics of the thrust of the propeller of FIG. **13** are illustrated by the arrows. The hub **124** rotates in the direction of the arrows **134** and each cylinder rotates in the direction of the arrows **136**. The rotation **134** causes a relative movement between the cylinders **128** and the fluid in which they are operating, for example air or water, and this relative movement is indicated by the flow arrows **137**. This combination of rotation of hub and cylinders results in a thrust toward the viewer which will propel the vessel forwardly away from the viewer of FIG. **13**.

Illustrated in FIG. **14** is a hydraulic drive when the motors **126** of FIG. **13** are hydraulic motors. A hollow propeller shaft **140** has an external gear **141** engaged by a drive spur gear **142** driven by a motor **143**. The motor **143** also drives through a shaft **144** a hydraulic pump **146** which takes liquid from an accumulator **147** and delivers it to a reversible valve having a body **148** and a control rotor **149** controlled by a valve handle **151** rotatable from the position shown to a position **152** shown in broken outline. The valve housing **148** has two outlets connected to pipes **153** and **154** which deliver fluid under pressure or exhaust fluid depending upon the position of the handle **151**. The two outputs are delivered to a stationary outer pipe **156** and the other output **154** is connected to a stationary pipe **157** disposed within the outer pipe **156**. The inner pipe **157** delivers its output to a rotating pipe **158** connected to the hydraulic motors **126** of FIG. **13** and the outer pipe **156** delivers its output to a rotatable pipe **159**. The joints between these rotatable and stationary pipes are sealed by rotating couplings **160**.

The operation of the device of FIG. **14** is as follows. The motor **143** is energized to rotate the spur gear **142** to rotate the hollow propeller shaft **140**, the left end of which houses motors **126** as shown in FIG. **13**. The motor **143** drives the pump **146** which takes liquid from an accumulator **147** and delivers it to a reversing and throttling valve **148-149**. In the position shown in FIG. **14** the fluid under pressure goes through conduit **154** to the rotating pipe **158** sealed by rotational coupling **160**. Exhaust fluid is received from the outer rotating pipe **159** through the stationary pipe **156** to the valve conduit **153** to return to the accumulator **147**. In this fashion fluid under pressure can rotate a hydraulic motor, for example, a vane type motor, in either direction to control the direction of rotation of the cylinders **128** of FIG. **13**. Not only does the valve **148-149** control the direction of flow, but by careful manual adjustment can control the amount of flow and thereby the speed of rotation of the rotors **128**. It will be appreciated that if the pump **146** pumps air rather than liquid, that the accumulator **147** and its return pipe will not be needed.

Referring to FIG. **15**, there is illustrated a circuit for supplying electricity to motors **126** of FIG. **13** when these are electric motors. The motor **161** drives a shaft **162** connected to a spur gear **163** which engages an outer gear **164** on a hollow propeller shaft **166**. Electric conductors **167** and **168** are connected to slip rings **169** and **171** respectively, which are secured to the rotating propeller shaft **166**. These slip rings are engaged by brushes **172** and **173** respectively, which in turn are connected to conductors **174** and **176** leading to a manual controller **177** which controls not only the direction of the current flow, but also the amount of flow so as to control the speed of rotation of the rotors **128** of FIG. **13**. The controller **177** receives its electric supply from a generator **178** driven in any suitable manner. The controller **177** may be of any desired construction, for example, the combination of the switch **63** and rheostat **61** of FIG. **5** for schematic purposes.

It will be appreciated that the control of the electric motors and for that matter the hydraulic motors of FIG. **14**, may be at the motors themselves rather than externally to the rotating propeller shaft. In this case hydraulic or electrical relays would be used rather than external manual control. The motors **120, 143** and **161** may also be reversible in which case the cylinder motors **126** need not be reversed nor the shaft **86** shifted. Motor **121** may be reversible in which case shifting is not required.

## INDUSTRIAL APPLICATION

The Reversible Magnus effect propellers of this application are useful in any type of boat, ship or other vessel as a propulsion mechanism. They are fully as useful as the common screw propeller, but are more efficient in reverse because the usual screw propellers are cupped for forward propulsion and therefore, are less efficient in reverse.

While I have described the invention with respect to presently preferred embodiments thereof these embodiments are illustrative only, and not limiting. There is included within the scope of the following claims all variations and modifications that fall within the true spirit and scope of the invention.

I claim:

**1**. A Magnus effect propeller for water vessels, comprising:

(a) a propeller hub rotatable about an axis;

(b) at least one Magnus cylinder rotatably mounted on the hub and rotatable about an axis that is radial to the hub axis, said cylinder having an outer end that defines a circle of revolution as the hub is rotated;

(c) a stationary propeller nozzle concentric with the hub axis at the circle of revolution of the cylinder end and having an internal annular groove having a forward edge and a rear edge;

(d) a round axial projection on the outer end of the cylinder that is of less diameter than said width of the groove and projecting into the groove;

(e) and means for shifting the hub along its axis so that the round cylinder projection contacts either the forward or the rear groove edge to rotate the cylinder in one direction or the other as it revolves about its hub axis.

2. Magnus effect propeller as set forth in claim **1** wherein element c is a ring disposed at the circle of revolution and the ring has said internal annular groove having a forward edge and a rear edge.

3. A Magnus effect propeller for water vessels, comprising:

(a) a propeller hub rotatable about an axis;

(b) at least one Magnus cylinder rotatably mounted on the hub and rotatable about an axis that is radial to the hub axis;

(c) a cylinder drive shaft concentric with the hub axis;

(d) a pair of spaced drive means connected to the cylinder drive shaft for alternatingly driving the cylinder in one direction or the other on its axis that is radial to the hub axis;

(e) means for shifting the cylinder drive shaft along its axis so that the cylinder is driven by only one of said spaced drive means;

(f) and power means for rotating the hub and the cylinder drive shaft.

4. A Magnus effect propeller for water vessels, comprising:

(a) a propeller hub rotatable about an axis;

(b) at least one Magnus cylinder rotatably mounted on the hub and rotatable about an axis that is radial to the hub axis, said cylinder having an outer end that defines a circle of revolution as the hub is rotated;

(c) a stationary propeller nozzle concentric with the hub axis at the circle of revolution of the cylinder end and having an internal annular groove having a forward edge and a rear edge;

(d) a round axial projection on the outer end of the cylinder that is of less diameter than said width of the groove and projecting into the groove; and

(e) means for shifting the hub and the nozzle relative to each other along the hub axis so that the round cylinder projection contacts either the forward or the rear groove edge to rotate the cylinder in one direction or the other as it revolves about its hub axis.

5. The method of reversing the thrust of a Magnus propeller having a hub rotatable in either direction about an axis and a Magnus cylinder connected to the hub and continuously rotatable in either direction about an axis that is generally radial to the hub axis comprising:

(a) driving continuously through multiple 360° rotations the hub and the cylinder with independent reversible power means;

(b) and reversing one of said power means.

6. A reversible Magnus effect propeller comprising:

(a) a propeller hub rotatable about a hub axis;

(b) at least one Magnus cylinder rotatably mounted on the hub and rotatable in either direction about an axis generally radial to said hub axis;

(c) means for rotating the hub;

(d) reversible power means connected to the Magnus cylinder and independent of the means for rotating the hub for rotating the cylinder in either direction;

(e) and manual control means for said reversible power means, whereby the propeller reverses thrust by reversing the direction of rotation of the cylinders.

7. A reversible Magnus effect propeller as set forth in claim **6** wherein element d) includes a rotatable shaft disposed within the hub and a mechanical drive between the cylinder and shaft, and the reversible power means is connected to the shaft.

8. A reversible Magnus effect propeller comprising:

(a) a propeller hub rotatable about a generally horizontal hub axis;

(b) at least one Magnus cylinder rotatably mounted on the hub and rotatable in either direction about an axis generally parallel to a radius to said hub axis;

(c) means for rotating the hub;

(d) a reversible, rotatable output motor disposed in the hub and coupled to the cylinder for rotating the cylinder in either direction;

(e) a power source connected to said motor to effect rotation in either direction;

(f) and means for reversing the direction of rotation of the motor.

9. A reversible Magnus effect propeller as set forth in claim **8** wherein the reversible motor is a fluid motor and the reversible power source supplies fluid under pressure to the motor.

10. A reversible Magnus effect propeller as set forth in claim **8** wherein the reversible motor is an electric motor and the reversible power source supplies electric current to the motor.

11. A reversible Magnus effect propeller comprising:

(a) a propeller hub rotatable in either direction about a hub axis;

(b) at least one Magnus cylinder rotatably mounted on the hub and rotatable in either direction about an axis generally parallel to a radius to said hub axis;

(c) a first reversible power means connected to the hub for rotating the hub in either direction;

(d) a second reversible power means connected to the cylinder for rotating the cylinder in either direction;

(e) and means for reversing the direction of rotation of one of said reversible power means; whereby reversing the direction of rotation of said hub or cylinder will reverse the Magnus thrust.

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